A Politico-Economic Model of Public Expenditure and Income Taxation[1]

Joan Esteban and Laura Mayoral[2]

February 19, 2014

Abstract

We model the political process as consisting of voting on the issue considered salient, public expenditure, with a subsequent consensus over size of government and income taxation. We prove that for each majoritarian choice there is a unique consensus policy on progressivity and government size. We empirically validate the implication that the sign of the relationship between inequality and progressivity chosen by the median voter is conditional on the degree of substitutability between government and market supplied goods. We also obtain that this substitutability has a negative impact on the negative marginal effect of inequality on the size of government.

JEL-Classification: H23, H50, 050.

Key-words: Government Policy, Income Taxation, Public Expenditure.

[1]Esteban and Mayoral research has been funded by the Generalitat de Catalunya and the CICYT (ECO2011-25293). Useful comments by Jordi Caballe, Eliana la Ferrara and Kalle Moene are gratefully acknowledged. Andrew Gianou has provided us with a highly competent research assistance.
[2]*Esteban*: Institut d'Anàlisi Económica, CSIC, and Barcelona GSE; joan.esteban@iae.csic.es. *Mayoral*: Institut d'Anàlisi Económica, CSIC and Barcelona GSE; laura.mayoral@iae.csic.es.

1. Introduction

Much of public finance has treated taxation and expenditure separately. The literature on income redistribution through taxes and cash transfers treats the net tax revenue as given and [implicitly] disregards how this revenue is spent. Likewise, the bulk of the public expenditure literature deals with the allocation of the budget over the different goods and services publicly provided, independently of taxation. Finally, there is also the highly debated question of the size of government in the economy. This paper provides an integrated analysis of these three dimensions of public finance.[3]

We model the choice over these three dimensions of public finance in line with the standard approach in political science by which the political debate and the vote are focused on a few salient issues while the rest is later resolved in a consensual way.[4] Empirical evidence strongly suggests that, among these policies, partisan confrontation essentially focuses on public spending and size of government.[5] We examine the case in which the expenditure policy is chosen by majority voting. Given this choice, the income tax schedule and the size of government are designed so as to achieve consensus among the population,

[3]The links between taxation and expenditure have been studied in theoretical welfare economics: Arrow (1971), Bergstrom and Blomquist (1996), Blomquist and Christiansen (1995, 1998), Blomquist et al. (2010), Boadway and Marchand (1995), Cremer and Gahvari (1997), Guesnerie and Roberts (1984), Meltzer and Richard (1985), and Pirttila and Tuomala (2002). In Besley and Coate (1991) and in Epple and Romano (1996) individuals vote over the quality/level of the public provision of a good and the budget balancing proportional income tax. See the survey by Balestrino (1999).
The macroeconomics literature has also given some attention whether public and private expenditures are complements or substitutes: Barro (1981), Aschauer (1985), Christiano and Eichenbaum (1992), Baxter and King (1993), Karras (1994), Ahmed and Yoo (1995), Ambler and Cardia (1997), Amano and Wirjanto (1998), and Cardia, Kozhaya, and Ruge-Murcia (2003) are all relevant contributions [more later].
[4]See Wlezien, C. (2005) for a survey on saliency in politics and how to measure it.
[5]In their codification of party manifestos in all democratic countries since 1945, Budge et al (2001, 2006) do not include as an entry neither income taxation nor income redistribution. In contrast, public expenditures such as environment, culture, social services, social security, health, or education represent nearly twenty percent of the total entries. Indeed, Cusack and Baramendi (2006), Ganghof (2005), Swank and Steinmo (2002), and Wagshal (2001), find no support for the influence of government composition on income taxation, while Bruninger (2005) and Tsebelis and Chang (2004) do find evidence of a significant effect on the type of public spending. In an influential paper, Przevorski (1999) makes the point that political struggles over spending levels may partly be fought as struggles over tax structure (p.43). On this respect, Cusack and Fuchs (2002) argue that this is so because large parts of welfare spending do not come in the form of transfers but rather as services and goods provided by the state (p.17). Also Howard (1997) and Ervik (2000) underscore the relevance of the "hidden" welfare provision.

thus avoiding an additional line of political confrontation.[6] We also study the case in which the political debate is focused on the size of government while the composition of public spending and the income tax are obtained via consensus. The model endogenously determines the consensus income tax schedule, the composition of public expenditure and the size of government.[7] We obtain that inequality is negatively related to the size of government and to the redistributive egalitarian bias in public expenditure, and positively or negatively related to the marginal income tax, depending upon substitutability between government supplied and market goods.

In our model income is taxed and the net tax revenue is used to finance the quasi private goods and services provided by the government.[8] As in Arrow (1971), we assume that the government can target the individual beneficiaries of its expenditure by choosing the weight given to types of expenditure that mostly benefit each specific segment of the income ladder. We consider two different expenditure principles. One is egalitarianism, providing a uniform benefit across the population. The other is incentive motivated and provides benefits in accordance to the individual fiscal effort. We parametrize the expenditure policies by the relative weight given to the egalitarian principle.

---

[6]See Bandyopadhyay and Esteban (2009) for a first exploration of the idea of consensual taxation and its empirical implications.

[7]Taking the recent report by the US *National Commission on Fiscal Responsibility and Reform* as a reference point, the opinions of some of the members [available at www.fiscalcommission.gov.] seem in line with our approach. That changes in taxation and in expenditure are linked to each other is plain in congressman Jeb Hensarling's words: *"... further tax increases on the American people should be off the table. If put on the table, as they are in this plan, fundamental health care reform and a total spending cap must be put on the table as well."* Senator Kent Conrad insists on this point and also on the need for a bipartisan consensus: *"Our obligation was not just to produce a plan that would bring America back from the brink, but to do so in a bipartisan way. And just as Senator Gregg and I believed was so important, everything was on the table —spending and revenues. The Commissioners, just like Congress, would have to make compromises to get this important job done."* This view of tax reform as a compromise rather than a confrontation is also present in similar discussions in other countries. Chris Wales, former advisor to the UK former Labor prime minister Gordon Brown, expressed the view that: "*In practice, there is little constructive debate even then about the level of taxation and even less about the way in which it is levied. (...) The result is that [in the Parliament] there is almost no examination of the design of the tax system as a whole. (...) The search for fairness may ultimately be futile. The search for a broad consensus is certainly not.*", at "Time for a new consensus on tax", *The Telegraph* (18/10/2007).

[8]Notice that the income that constitutes the tax base includes social security transfers. Hence, we are not dealing with how such transfers are determined. The redistributive task of the government via money transfers has been the object of extensive studies by Moene and Wallerstein (2001a), (2001b) and (2003) and Alesina and Glaeser (2004).

The impact of the public provision of goods on individual well-being critically depends on the substitutability relative to the ones individuals purchase in the market. This will also be critical with respect to attitudes of the rich towards taxation. For instance, when security was the monopoly of the state police, rich individuals with a high demand for security had to accept a well-funded government because there was no substitute in the market. As it turns out, this substitutability plays a key role in the relationship between inequality and income taxation and size of government. We take this substitutability as given and leave for future research the rationale of the privatisation of public services.

What is the net value added of our shifting of partisan competition from taxes to public expenditure or size of government? Besides bringing the model closer to what appears to be the actual political process, this shift yields three interesting novel insights: (i) it brings into stage the interdependence between taxation and distributive expenditure; (ii) it unveils the impact of public decisions modifying the substitutability between publicly supplied goods and market goods, and (iii) it explains why inequality has a non-monotonic relationship with income tax progressivity.

We bring the model to data and find empirical support for the two main implications of our model:

[1] *There is a positive relationship between the marginal tax rate and inequality when the elasticity of substitution is low, and a negative relationship when the elasticity is high.*

The analysis of the relationship between redistribution and inequality has been dominated by the politico-economic model of majority voting over linear income taxes. This literature was initiated by Romer (1975), Roberts (1977), and Meltzer and Richard (1981). In this model the chosen tax is the one preferred by the median income voter, and hence more inequality —increasing the relative gap between mean and median income— leads to more redistribution. Intuitive as it may sound, this theory has been unable to obtain

convincing empirical support.[9] In contrast, our empirical results show that there is a relationship between taxation and inequality, once its sign is conditioned to the elasticity of substitution public/private.

[2] *The size of government is negatively related to inequality. In addition, the marginal effect of inequality on the size of government is larger (in absolute value) the lower the value of the substitutability.*

Our second empirical result refines the finding of a negative relationship between total government expenditure and inequality,[10] by introducing in the discussion that the critical variable is the interaction between inequality and substitutability.

The paper is organized as follows. In section **??** we present the model. In section **??** we develop the notion of consensus and obtain the policy that will result from majoritarian vote on either composition of government spending or on size of government and obtain the corresponding consensual other fiscal policies. Section **??** empirically tests the two main implications of our model and section **??** concludes. All proofs are in Appendix A. Appendix B presents some tables related to the empirical analysis that are not included in the main text.

2. The Model

We assume a continuum of individuals with income denoted by y. Individual income is exogenous and distributed over the population with cdf F with support $[a, \infty), a > 0$. We

[9]Borck (2007) concludes in his survey that there is no solid evidence in support of the critical role of the median income voter. An updated survey of the negative empirical results can be found in Scervini (2012). Moene and Wallerstein (2003) find that redistributive social transfers appear to be uncorrelated with inequality while insurance seems negatively correlated with inequality. Mello and Tiongson (2003) also find that higher inequality goes with lower spending in redistribution. But Shelton (2007) finds that increased inequality results in strong increases of transfers.

[10]Schwabish et al (2006) find that higher pre-tax market income inequality leads to lower levels of non-elderly social spending. Moene and Wallerstein (2003), Shelton (2007) and Longoni and Gregorini (2009) find that income inequality has no influence on the aggregate provision of public goods. Husted and Kenny (1997) and Rodríguez (1999) find that higher income inequality among voters following an enlargement of the franchise has the effect of enlarging the size of government.

are thus implicitly assuming a rigid labor supply.[11] We shall denote the average per capita income by μ.

Individual preferences are defined over private consumption x and a publicly supplied good g. The publicly supplied good can be public or private in nature or a mixture of the two. The essential distinguishing feature here is that x is purchased in the market while g is fixed by the government. Individual preferences are represented by $u(x, g)$.

On individual preferences we make the following standard assumption:

Assumption 1. $u_x > 0$, $u_g > 0$, $u_{xx} < 0$, $u_{gg} < 0$ *and* $u_{xg} > 0$. *For* $g > 0$, $\lim_{x\to 0} u_x = \infty$ *and* $\lim_{x\to\infty} u_x = 0$, *and for* $x > 0$, $\lim_{g\to 0} u_g = \infty$ *and* $\lim_{g\to\infty} u_g = 0$.

Let $t(y)$, $0 \leq t(y) \leq y$, denote the tax paid by an individual with income y. The entire disposable income is consumed and hence

$$x(y) = y - t(y). \tag{1}$$

We denote by $\bar{t}$ the per capita net tax revenue, i.e.

$$\bar{t} = \int t(y)dF(y). \tag{2}$$

The net tax revenue is used to finance the provision of the publicly supplied commodities.

Suppose we could transform an amount z of private consumption into publicly supplied good. Then, the utility of shifting z is $u(y - z, z)$. Consider now the utility maximizing z for an individual with income y. Let us denote by $z(y)$ this optimal shift of resources from private to publicly supplied goods. Then we have that $z(y)$ solves

$$u_x(y - z(y), z(y)) = u_g(y - z(y), z(y)). \tag{3}$$

We denote by $\hat{z}$ the share of the average shift over per capita income, that is, $\hat{z} = \int z(y)dF(y)/\mu$. This is a useful benchmark as it gives us the relative size on GDP of the

[11] Most of the models on public expenditure consider individual incomes as given. This is the case of Arrow (1971), Usher (1977), Epple and Romano (1996), or Besley and Coate (2001). In any case, as we will show at the end of subsection **??**, this assumption does not alter our essential results.

publicly supplied good if each individual had to choose the allocation between private and public that is optimal to her, in absence of redistribution.

We are interested in the type of goods and services provided by the government. The structure of the public expenditure is important because, by choosing the weight allocated to the different types of goods and services, it establishes the distribution of its benefits. Transferring resources from primary education or from health to research, for instance, tilts the benefits of public expenditure towards rewarding the tax effort of the high taxpayers. Although we will treat public expenditure as an aggregate, we want our model to capture the distributive bias implicit in expenditure policy. As we have already argued, in the political debate the preference over the size of government comes together with an associated expenditure and taxation policy.

A stark way of representing the distributional impact of public expenditure is to consider the chosen policy as a compromise between two principles that seem to inspire the debate. On the one hand, we have the principle of *universal and equal treatment* of all the citizens. This principle recommends a structure of public expenditure that produces an equal benefit across the board. On the other hand, we have the notion of making the benefits of governmental action to be proportionate to the *fiscal effort* exerted by the different tax payers.[12] The stronger the role of the egalitarian principle, the more beneficial to the poor the policy will be.

We shall consider public expenditure as a compromise between the two extreme cases of the distribution of benefits from public supply of goods and services. In the first case, public expenditure fully adheres to the egalitarian policy and chooses a structure of public expenditure that yields an equal benefit to all the citizens, $g(y) = \bar{g}$. The second benchmark corresponds to the case in which public spending is fully responsive to the principle of rewarding the taxpayer effort and thus returns as benefits to each taxpayer the exact amount of taxes paid, $g(y) = t(y)$.

[12]When discussing the principles for tax reform, US senator Tom Coburn states that "those who benefit from the taxes of others have an obligation to pay their own taxes and be better stewards of the hard-earned dollars they have been entrusted." *National Commission on Fiscal Responsibility and Reform* http://www.fiscalcommission.gov/sites/fiscalcommission.gov/files/documents/MemberStatements.pdf.

We consider the family of expenditure policies that are intermediate between these two extreme positions. An expenditure policy specifies the benefits at each income level y as a weighted combination of the two benchmark policies.[13] Therefore, we define an *expenditure policy* as the convex linear combination of the two extreme policies, where $\gamma \in (0,1)$ is the weight to the egalitarian policy so that:

$$g(y,\gamma) = \gamma\bar{g} + (1-\gamma)t(y). \tag{4}$$

The larger the value of γ the more redistributive the expenditure policy is. The size of government is $\vartheta = \frac{\bar{g}}{\mu}$.

A *fiscal policy* will thus consist of an income tax and an expenditure policy: $\big[t(\cdot), \bar{g}, \gamma\big]$.

Later we will require that the chosen fiscal policies be *balanced*, that is,

$$\bar{g} \equiv \int g(y)dF(y) = \gamma\bar{g} + (1-\gamma)\int t(y)dF(y) = \gamma\bar{g} + (1-\gamma)\bar{t} = \bar{t} = \vartheta\mu. \tag{5}$$

The utility of an individual with income y from the fiscal policy $\big[t(\cdot), \gamma\big]$ [maybe unbalanced] is

$$u\big(y - t(y), \gamma\bar{g} + (1-\gamma)t(y)\big). \tag{6}$$

Let us now consider the marginal utility of publicly supplied goods u_g for an individual with income y and paying taxes $t(y)$. A marginal increase in the tax paid will decrease private consumption and increase the consumption of the publicly provided good, because of one's higher deservingness. The joint effect of these changes clearly is a *decrease* in u_g. Our assumption is that the elasticity of this change in the marginal utility of the publicly provided good is less than unity. Formally, our assumption is as follows.

Assumption 2. *We assume that for all incomes and all* $\gamma \in (0,1)$

$$-\frac{t(y)}{u_g}\frac{\partial u_g}{\partial t(y)} \leq 1. \tag{7}$$

We are now set for the study of the choice of fiscal policies.

[13] This class of policies is a specification of the targeted expenditure policies considered in Arrow (1971).

3. Choice of Fiscal Policy

We assume that, given the voted expenditure policy, the political actors —political parties, civil servants, parliamentary committees, lobbies, or expert advisors— look for a reform of the distribution of the tax burden that minimizes controversy and no additional front of party confrontation is left open. Indeed we show that for any given expenditure policy there exists a unique *consensual* tax function, with the corresponding net tax revenue and the budget balancing size of government. Knowing that the tax will be adapted to make it consensual, the expenditure policy is chosen by majority voting. Consequently, we have a simultaneous determination of expenditure and taxation policies.

We solve the problem backwards. We first show that for each expenditure policy γ a unique balanced consensual tax schedule $t(\cdot)$ exists. Then we deal with voting over expenditure policy γ.

3.1. **Consensual fiscal policy.**

Consider any arbitrary expenditure policy γ. We shall show that for any such policy there is a unique $\bar{g}$ and balanced income tax function $t(y)$ that is consensual.

A tax function is any strictly increasing function from $\Re$ to $\Re$ with any arbitrary net tax revenue $\bar{t}$ satisfying that $t(y) \in [0, y]$.

For any arbitrary $\bar{g}$, the tax function $t(\cdot)$ is *acceptable* to an individual with income y if she does not wish to vary its progressivity and it is *consensual* if it is unanimously acceptable and balanced.

In order to operationalize the notion of "variation of the progressivity" of $t(\cdot)$ —without varying the net tax revenue— we focus on affine transformations $\tilde{t}(\cdot)$ that satisfy:

$$\tilde{t}(y) = \bar{t} + \beta[t(y) - \bar{t}]. \tag{8}$$

For any given $(\bar{g}, \gamma)$, the valuation of a change in progressiveness by β of the tax $t(\cdot)$ by an individual with income y will be

$$u\big(y - \big[\bar{t} + \beta(t(y) - \bar{t})\big], \gamma\bar{g} + [1-\gamma]\big[\bar{t} + \beta(t(y) - \bar{t})\big]\big). \tag{9}$$

Given the fiscal policy $\left(t(\cdot), \bar{g}, \gamma\right)$ we denote by $\beta^*(t(y), \gamma, y)$ the change that would be preferred by an individual with income y. Since the utility is strictly concave in β, the most preferred change in progressiveness can be obtained from the first order condition.

Definition 1 *(i) A fiscal policy* $\left(t(\cdot), \bar{g}, \gamma\right)$ *is individually acceptable to a person with income* y *if* $\beta^*(t(y), \bar{g}, \gamma, y) = 1$. *The set of tax functions acceptable to an individual with income* y *is denoted by* $\Im(y, \bar{g}, \gamma)$.

(ii) A fiscal policy $\left(t(\cdot), \bar{g}, \gamma\right)$ *is consensual if it is unanimously acceptable and balanced, that is, if* $t(\cdot) \in \bigcap_y \Im(y, \bar{g}, \gamma) \equiv \Im(\gamma)$ *with* $\bar{t} = \bar{g}$.

Proposition 1. *Let individual preferences satisfy Assumption* **??**. *For any income distribution* $F(\cdot)$ *and any given* $\gamma \in (0, 1)$ *the set* $\Im(\gamma)$ *is non-empty and contains one single element only.*

Let us pause to underscore four points on the result.

[1] The first point refers to the restriction on the tax function: the set $\Im(y, \overline{g}, \gamma)$ contains tax functions yielding very different aggregate tax revenues. The restriction that a tax function is consensual, and hence acceptable to all, selects not only the consensual steepness of the tax function, but its net revenue as well. The aggregate tax revenue —and hence the size of government ϑ— is determined together with the shape of the tax function.

[2] Our second point concerns the importance of the assumption that incomes are exogenous. The existence of a consensual tax function remains intact with an elastic labor supply. To see this observe that, written in compact form, the preferred β implies that $\frac{du}{d\beta} = \frac{du}{dt(y)}[t(y) - \bar{t}] = 0$. We then examine the implications that this condition is satisfied for $\beta = 1$ for all incomes. Now income would be $y = w\ell$, where ℓ is labor supply and w the wage rate. Preferences will now (negatively) depend on a third commodity: labor supply ℓ. The utility maximizing choice of ℓ would entail that the total marginal effect on utility be zero, that is, that $\frac{du}{d\ell} = 0$. Now, the effect on the utility of a change in β depends on the total direct effect on utility of changing the tax, together with the induced change in utility via the change in labor supply. This total change has to equal zero. If we

compute the total change we now have $\frac{du}{dt(y)}[t(y)-\bar{t}]+\frac{du}{d\ell}\frac{d\ell}{dt(y)}[t(y)-\bar{t}]$ that, by an envelope argument, reduces to the previous expression $\frac{du}{dt(y)}[t(y)-\bar{t}]=0$. We have opted for a rigid labor supply for the sake of the clarity of our arguments.

[3] Our third point wishes to stress that consensual taxes are welfare maximizing relative to the other tax schedules with the same net tax revenue.[14] Notice that the requirement that for the chosen $t(\cdot)$ no one can improve upon by local affine transformations is in fact a variational condition to characterize a function that maximizes the sum of individual utilities.

[4] Finally, Proposition **??** can be reworded for the case of a given size of government ϑ and balanced and consensual $t(\cdot)$ and γ.

Proposition 2. *Let individual preferences satisfy Assumptions* **??** *and* **??**. *For every* $\vartheta \in [0,\hat{z}]$, *there always exist a unique consensual and balanced fiscal policy* $\left(t^*(\cdot),\gamma^*\right)$.

In sum, given the choice of either the size of government or the bias in public expenditure, the other fiscal policies can be accommodated so as to avoid a second dimension in the partisan competition.

In the proof of Proposition **??**, we have shown a result that we wish to single out.

Proposition 3. *Let preferences satisfy Assumptions* **??** *and* **??** *and let* $\vartheta \in [0,\hat{z}]$. *Then, over balanced consensual fiscal policies, the egalitarian bias of public expenditure* γ *is strictly decreasing in the size of government* ϑ.

This is a strong implication of our model of choice of fiscal policy: more egalitarian minded expenditure policies will be at the cost of reducing the size of government to make fiscal policy unanimously acceptable.[15]

[14] This seems in line with the intuitive argument by Buchanan and Tullock (1962) in *The Calculus of Consent*: "Any rule for collective choice embodying less than full consensus must impose some external costs on the individual since resources will tend to be allocated 'inefficiently because of the choice mechanism" (p.190)

[15] This negative relationship seems in line with the discussions of the US *National Commission on Fiscal Responsibility and Reform*. After Obama's increase in expenditure in health care, the sole main agreement reached by this commission has been to target a cap on size of government of 21 percent of GDP. This is four percent points below the size in 2011.

3.2. **Majority Voting over Public Spending.** We have already argued that political scientists have underscored that political confrontation takes place more in the domain of public expenditure than in the setting of income taxation. We have characterized the *consensus* tax function —and the corresponding net tax revenue— as a function of the expenditure policy. We shall now examine the choice over expenditure policies by majority voting.

For the choice over expenditure policies we shall simply transpose the analysis of majority voting over linear income taxes by Romer (1975), Roberts (1977) and Meltzer and Richard (1981). Our problem of choice over the pro-poor bias in expenditure policy is formally similar to the choice over the marginal tax rate t studied in this literature. In fact, a linear income tax makes disposable income the convex linear combination of the egalitarian mean income and the individual pre-tax income with weights t and $(1-t)$, respectively. Furthermore, when voting for the egalitarian "bias" t, individuals are assumed to be aware of the effect on labor supply and hence on per capita income. In our case too, voters will be assumed to take into account that the income tax will be reshuffled following the choice of γ.

We can now show that a majority voting equilibrium always exists.

Proposition 4. *Let $t(\mu) \leq \bar{t}$ and $m < \mu$, with $F(m) = \frac{1}{2}$. Then, a majority voting equilibrium always exists and the chosen expenditure policy, γ^*, is the one preferred by the median voter $\gamma(m)$, that is,*

$$\gamma^* = \gamma(m) = \frac{\bar{t} - t(m)}{-\frac{d\bar{t}}{d\gamma}}. \tag{10}$$

Likewise, an equilibrium of majority voting over ϑ always exists and consists of the policy preferred by the median voter.

Our result has a flavor of the classic Meltzer and Richard characterization of the majoritarian linear income tax. In their case, that marginal tax rate was proportional to the gap between mean and median incomes, measured at the endogenously determined labor supply. In our case, the chosen egalitarian bias in expenditure policy is proportional to

the gap between the taxes paid by the mean and median income earners, also measured at the endogenously determined tax schedule.

We close this subsection with a caveat on the interpretation of the result obtained. Within the tradition of the political economy of taxation literature, we have modeled the choice of policy as resulting from majority voting and hence aligned with the preferences of the median voter. This is indeed a very simplified representation of the working of a democracy unquestionably far from what we observe in reality. In fact, in our empirical work, as almost all empirical works on this topic, we shall use the Gini index as a measure of inequality. This is in line with a broader understanding of the connection between inequality and the pressure for redistribution.

In the next subsection we derive explicit close form solutions for the case of CES preferences.

3.3. **CES preferences.** We now restrict individual preferences to be of the CES type. This will permit us to obtain close forms and examine the effects of income inequality, of expenditure bias and of the elasticity of substitution on the tax schedule and on the size of government. In the rest of the paper we shall empirically test the implications of the model under the CES specification.

The family of CES utility functions is given by:

$$u(x,g) = \left[x^{\frac{\sigma-1}{\sigma}} + g^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{11}$$

with the elasticity of substitution $\sigma > 0$.

The first order condition for a consensus tax now is

$$\frac{u_x(x,g)}{u_g(x,g)} = \left[\frac{y - t(y)}{\gamma \bar{t} + (1-\gamma) t(y)} \right]^{-\frac{1}{\sigma}} = 1 - \gamma. \tag{12}$$

We can thus easily obtain that the consensus income tax is linear

$$t(y) = \frac{(1-\gamma)^{\sigma} y - \gamma \bar{t}}{(1-\gamma) + (1-\gamma)^{\sigma}}. \tag{13}$$

Integrating over the incomes y we have that

$$\bar{t} = \frac{\mu(1-\gamma)^{\sigma}}{1+(1-\gamma)^{\sigma}} = \bar{g} \text{ and } \vartheta = \frac{(1-\gamma)^{\sigma}}{1+(1-\gamma)^{\sigma}}. \tag{14}$$

Therefore, the linear tax schedule will have marginal tax rate τ and transfer T

$$\tau = \frac{(1-\gamma)^{\sigma}}{(1-\gamma)+(1-\gamma)^{\sigma}} \text{ and } T = \frac{\gamma\mu}{\left[1+(1-\gamma)^{1-\sigma}\right]\left[1+(1-\gamma)^{\sigma}\right]}. \tag{15}$$

Notice that an increase in the egalitarian bias in public spending γ will increase or decrease the marginal tax rate τ as the elasticity of substitution is smaller or greater than unity, respectively.

Finally, using (**??**) the majoritarian expenditure policy γ^* is implicitly defined by

$$\sigma\gamma^* \frac{1+(1-\gamma^*)^{\sigma-1}}{\left[1+(1-\gamma^*)^{\sigma}\right]^2} = \frac{\mu-m}{\mu} \equiv M. \tag{16}$$

We summarize the results obtained for CES preferences in the following Proposition.

Proposition 5. *Let individual preferences be CES and let income inequality be measured by the index M. Then we have that:*

(1) *the egalitarian bias in public spending γ is strictly increasing in inequality;*
(2) *the size of government ϑ is strictly decreasing in inequality. Further, the marginal effect of inequality on ϑ is larger (in absolute value) the lower the value of σ; and*
(3) *the tax schedule is linear and the marginal income tax rate increases or decreases with inequality as the elasticity σ is smaller or greater than unity.*

3.4. **Discussion.** [1] The degree of substitutability is essential in the relationship between the egalitarian bias and taxation. To see this, consider the case of publicly supplied goods with no substitutes in the private market. To have an adequate supply of the indispensable publicly supplied goods the rich have to accept a high level of taxation, even if they will also be financing the public supply to the poor. As the expenditure policy becomes more egalitarian, the rich will have to accept higher taxes. However, if the two types of goods

are substitutes, the rich will prefer to purchase privately the public ones and the effect of a more egalitarian expenditure policy will be avoided by reducing taxation.

[2] With no assumptions on the tax function, and with CES preferences, we obtain that the unique consensual $t(\cdot)$ is a linear tax function. Consider the effect of an increase by Δ of an income y. Due to the biased expenditure policy, a linear income tax implies that private and public consumption will also increase at the same rate. If preferences had a falling elasticity of substitution of private for public consumption, the income increase would make individuals prefer a more than proportional increase in the supply of the public good and hence would rather favor an increasing marginal tax rate. If the elasticity of substitution were to rise individuals would have a preference for declining marginal tax rates. Clearly, whether individuals unanimously support a tax function with increasing or decreasing marginal tax rates critically depends upon the change in the elasticity of substitution as the consumption levels rise. A similar argument holds for why the tax rate is shown to be independent of the distribution of income.

[3] In our model, the supply of a subset of commodities is the monopoly of the government. This monopoly provides the government with the coercive power to make individuals accept taxation on incomes. How effective this power is critically depends upon the substitutability between this bundle of commodities and the commodities individuals can purchase in the market. Hence, our approach suggests that the rich will lobby more strongly for increasing the substitutability between public and private goods by privatizing as many public services as possible rather than about the shape of the income tax schedule.

4. Empirical Evidence

When preferences have constant-elasticity of substitution, we have been able to obtain explicit, close-form testable results on the relationship between income inequality and fiscal policy, as recorded in Proposition **??**.

We obtain two types of results. One type is the direct effect of inequality on the chosen policy. This can be either on the egalitarian bias of expenditure policy or on the size of

government. The second type is the indirect effect of inequality on income taxation, via the consensual arrangement associated with the chosen expenditure policy.

In the following we present evidence supporting the direct and indirect effects of income inequality on fiscal policies. Concerning the direct effects, we have focused on the relationship between inequality and the size of government. We have good data on the size of government for a large sample of countries. In contrast, the specification of the notion of "egalitarian bias" in public expenditure can be controversial, and the data to proxy γ limited and of questionable interpretation.

Therefore, based on our results in Proposition **??**, we test the following two statements:

(1) There is a positive relationship between the marginal tax rate τ and income inequality when the elasticity of substitution σ is low, and a negative relationship when σ is high.[16]

(2) The size of government ϑ is negatively related to inequality. In addition, the marginal effect of inequality on the size of government is larger (in absolute value) the lower the value of σ.

4.1. **Data.** We use an unbalanced panel of 131 countries for the period 1981-2008. A description of the variables employed in the empirical analysis is provided below while a table containing summary statistics is presented in Table **??** in Appendix B.

Dependent variables. Our two dependent variables are τ, the marginal income tax rate, and the size of government, ϑ. These variables are measured as follows.

- τ is proxied by the top statutory marginal PIT rate, which is defined as the legally determined marginal tax rate applicable to the top bracket of the personal income tax schedule. This is the only tax schedule information systematically collected for a large sample of countries. The data comes from the World Tax Indicators database, International Center for Public Policy at Georgia State University, see Sabirianova et al. (2010) for details.

[16] A first attempt at estimating this relationship is in Bandyopadhyay and Esteban (2009).

- ϑ is measured as the ratio of the general government final consumption expenditure as a proportion of total GDP. Data comes from the WDI and GDFs databases from the World Bank.

Independent variables. The key independent variables in our analysis are income inequality and the elasticity of substitution, σ.

- Income inequality is captured in the model by M, the median to mean income gap. Data on M are only available for a few country/years. Thus, we have opted to proxy M by the Gini coefficient, G, which is the most popular index of inequality. Data for G come from the Standardized World Income Inequality Database (SWIID), (Solt, 2009). The SWIID provides comparable Gini indices of market and net income inequality for 153 countries for as many years as possible from 1960 to the present. We use Gini indices of market income inequality which, according to the SWIID definition, are based on pre-tax and pre-government transfers income.[17]
- σ has been proxied as follows.[18] The substitutability between the two bundles of commodities depends upon the nature of individual preferences and on the degree of monopoly that the government maintains for some subset of commodities, as discussed earlier. We focus on the latter property since data on public and private expenditure can be more easily accessed. For many OECD countries the security or the postal systems, for instance, have been a public monopoly until fairly recently. Today, however, it is possible to supplement the public supply of police force or mail services by purchasing additional private security or hiring courier companies. Our proxy for σ is based on the idea that the larger the share of the expenditure channelled through the market, the higher the substitutability between the public and the private provision of these goods. This suggests a simple way to approximate

[17]This dataset combines data from WIDER and other sources to predict missing values in the LIS "mi" (market income) series.

[18]There are numerous studies that have dealt with the estimation of the elasticity of substitution between public and private goods (i.e., Barro 1981, Aschauer 1985, Karras 1994, Evans and Karras 1996, Bouakez and Rebei 2006, Auteri and Constantini 2010, etc.). However, most of this literature has paid more attention to the sign of the cross derivative than to the value of the elasticity itself. In addition, these studies typically focus on a limited number of countries. Thus, we can't make use of these estimates in our empirical analysis.

σ as the ratio of private versus public spending on some set of commodities for which public provision is usually available.[19] If all is private, then the elasticity is infinity. If all is public, then the elasticity is zero. A reasonable candidate is health services, since they account for a considerable share of total's government expenditure but this share varies significantly from country to country.

Thus, we proxy σ as the ratio of private to public expenditure on health. Data on health expenditures comes from the Global Health Observatory database, World Health Organization and is available for the period 1995-2008 for a large number of countries (193). Our proxy for σ, σ^*, is computed as the average of the yearly ratios of private over public health expenditures for each country. Table **??** in Appendix B presents the values of this variable for each of the countries in our dataset.

Indeed, this is a rough proxy for the 'true" elasticities of substitution and in the best of cases it contains a sizable measurement error. In the empirical part, we nevertheless try to overcome this limitation by instrumenting σ^*.

Controls. Other variables that have been pointed out to have an impact on public spending and taxation decisions are also included in our regressions. These control variables remain the same in all our specifications.

- GDPPC. (Log of) income per capita in 2005 PPP dollars, lagged one year (source: Penn World Tables). The rationale for considering this variable is the observation of a positive association between the size of the public sector and income per capita (also known as Wagner's Law), see Easterly and Rebelo (1993).
- POP: Total population, lagged one year (source: Penn World Tables). Another classical observation is the fact that larger countries tend to spend less on public good provision. Alesina and Wacziarg (1998) provide two explanations for this fact.

---

[19] With CES preferences we have that $\frac{u_x(x,g)}{u_g(x,g)} = \left[\frac{x}{g}\right]^{-\frac{1}{\sigma}}$. Hence, we can write

$$\sigma = 1 - \frac{\ln \frac{u_x x}{u_g g}}{\ln \frac{u_x}{u_g}}.$$

Thus, if the variability of $\frac{u_x}{u_g}$ across countries is moderate, σ is an *increasing* function of the ratio between private to public value of consumption. Notice that from the first order condition (**??**) we have that $\ln \frac{u_x}{u_g} = \ln(1-\gamma) < 0$.

First, non-rivalrous public goods are shared over larger populations, which results in lower per-capita costs of provision. Second, larger populations tend to exhibit greater heterogeneity in preferences and this often leads to a decrease in public good provision.

- POP65. Percentage of population above 65 years, lagged one year (source: the World Bank). A greater fraction of the population over 65 is often associated with large and significant increases in local government expenditure (Shelton, 2007).
- DEMOC: Democracy indicator, lagged one year (source: Polity IV).[20] Our theory implicitly assumes that the median income and the decisive voter are the same citizen. However, political rights are restricted to a privileged minority in many countries. We control for the extent of democracy since our sample includes countries with quite heterogeneous political institutions.
- Finally, all our regressions include country fixed effects and year dummies.

4.2. **The relation between the marginal tax rate and inequality.** In this section we investigate the relationship between the top marginal tax rate, τ, and inequality, which in Section **??** is established to be conditional upon the value of σ, the elasticity of substitution between public and private expenditures.

Our model implies that for low values of σ there exists a positive relationship between τ and inequality, that becomes negative for higher values of σ. A simple way to capture this relation is to consider a linear regression where the marginal tax rate is regressed on inequality and inequality interacted with σ^*, our proxy for σ, plus some controls. We would expect a positive coefficient for inequality and a negative one for the interacted term, such that for small values of σ^* the combined effect is positive, but it becomes negative for larger values.

Reverse causality may pose a problem in our empirical analysis. Firstly, income inequality may have an effect on the marginal tax rate, as the model postulates. Yet, the amount

[20]The Democracy indicator ranges from 0 to 10, where higher values indicate better democratic institutions. Three variables are considered to elaborate this indicator: the competitiveness of political participation, the openness and competitiveness of executive recruitment, and constraints on the chief executive.

of redistribution that is possible to implement with the raised taxes might also have a direct effect on inequality. Notice however that our measures of inequality are based on market income. This is income before taxes have been collected and before redistribution by the state has taken place. Thus, taxation and social spending have no direct effect on this type of inequality (Milanovic, 2000).[21]

Although a direct link between taxes and market income inequality can be ruled out, an indirect link cannot be discarded. Individual labor supply decisions are likely to be affected by the welfare state and the degree of taxation. High top marginal rates may induce households at the higher end of the income distribution to reduce their labor supply, thus lowering their income. A generous welfare state can have a similar effect at the lower end of the income distribution, since individuals may prefer to work less and receive compensation by the state. To address this issue, we lag our measures of inequality and assume that current changes on the tax rate do not have an impact on lagged inequality. Lagging the inequality measures has an additional benefit, since it is natural to expect that changes in the marginal tax rate will occur with some delay with respect to changes in inequality. Three reasons will justify this lag. Firstly, households will need some time to recognize that their relative income position has changed. Secondly, elections do not take place annually, so changes in voter preferences have to wait in most instances until they can effectively be expressed. And thirdly, newly elected governments will also require time to implement policy changes.

Secondly, our proxy for the elasticity of substitution between private and public goods, σ^*, might also be endogenous. Countries with low marginal tax rates might be forced to have low public spending and, therefore, a high value of σ^*. This would generate a negative relation between σ^* and τ, and biased estimators due to reverse causality. We will address this problem by instrumenting σ^*, see below for a discussion.

[21]Just to give an idea of how different inequality based on market or net income looks like, consider the case of Sweden. Sweden is known as being a country with high levels of redistribution and low inequality. Indeed, its average net income Gini over the period considered in this analysis equals 0.23, which implies that 98% of the countries of our sample have levels of (net income) inequality that are larger than this value. However, Sweden's average market income Gini is 0.44, which is above the inequality's median value (55 percentile) and is comparable with that of countries such as Cambodia or Trinidad and Tobago.

We estimate the following model for several values of j, the inequality lag,

$$\tau_{it} = \beta_1 G_{it-j} + \beta_2 G_{it-j}\sigma_i^* + \beta_3 X_{it-1} + \mu_i + \eta_t + \epsilon_{it}, \tag{17}$$

where the subscripts $i = 1, ..., C$ and $t = 1, ..., T$ denote country and year, respectively, G is the Gini coefficient, σ_i^* is our proxy for the elasticity of substitution between private and public goods, X_{it-1} is a vector of controls (lagged one year), μ_i and η_t are country and year dummies, respectively, and ϵ_{it} is the error term. We have estimated the coefficients using standard fixed-effects and instrumental variable techniques. Robust standard errors adjusted for clustering at the country level have been employed in all regressions.

Our main focus is on the effect of inequality lagged five years on the marginal tax rate. This lag is convenient since it ensures that enough time has gone by for elections to take place and new tax policies to be implemented. In addition, this makes our results more comparable with related papers that aggregate the data in 5 year intervals (as Mohl and Pamp 2009, or Shelton 2007). For robustness, we have also considered different lags (4 and 6 years). Table **??** presents our main results. Column 1 considers the relation between the top marginal rate and inequality lagged five years, after imposing $\beta_2 = 0$ in equation (**??**). The coefficient of inequality is negative but not significant. In column 2, the same relation is estimated, this time without imposing $\beta_2 = 0$. According to the individual t-tests, both β_1 and β_2 are significant, the former with a positive sign and the latter with a negative one, just as the theory predicts.[22] This implies that for moderate values of σ^* (smaller than 1.34), the relation between the marginal tax rate and inequality is positive. It turns out to be negative, however, for countries with large values of σ^*. The value 1.34 corresponds approximately to the 74% percentile of the distribution of σ^*. The U.S., for instance, has a value of σ^* equal to 1.25 and, therefore, the model predicts a (small) positive relation between inequality and the top tax rate.[23]

Instrumenting σ^*. As mentioned above, one caveat of the last regression is that the coefficients might be biased due to endogeneity of the elasticity of substitution between private

[22] We can also reject the hypothesis that both coefficients are jointly zero, the p-value of the corresponding F test being 0.003.

[23] See Appendix B for a list of countries and values of σ^*.

and public goods. In order to find exogenous determinants of σ^*, we have explored the history of the public health system. Its origins date back to the XIX century. At this time, society was experiencing a profound transformation. Industrialization had brought about a rapid urbanization process. The poverty and the lack of basic sanitation in the working class districts of the growing cities provided efficient breeding grounds for communicable diseases. Infants and young adults died in their millions of measles, whooping cough, smallpox, diphteria, tuberculosis and diarrhea. However, the most devastating epidemics were cholera and typhus that affected people in all age groups. Understanding epidemic diseases in the new society and how to control them required a rethink. Traditional patterns of quarantine and isolation employed in the control of plague proved to be inadequate. In addition, diseases, specially cholera, created violence, rioting and social unrest. At the end of the XIX century, European countries implemented the first state interventions to control epidemics and improve sanitary conditions in mass urban populations, giving rise to the public health system.

Among the many factors that contributed to this development, two seem key.[24] One, as mentioned above, is the rapid population increase in industrialized cities. The second, is the expansion of trade during the nineteenth century, which was the most important vehicle for the spread of cholera (Porter, 1999). The water-borne disease was carried by sailors, traders and shipping workers. Service occupations involving water were always the first groups to succumb.

The importance of trade in a country is connected to the availability of ports. Then, it is reasonable to expect that the ratio of kilometers of coast line over total area, COAST, is positively related to maritime trade. This would imply that this variable is also positively related to the development of the public health system and, therefore, inversely related to σ^*. On the other hand, cities tend to develop and grow more in flat areas that are easily accessible and well communicated. Thus, highly mountainous areas are in principle less suitable for large scale urbanization. To capture this, we use the proportion of the country that is mountainous according to the codings of geographer A. J. Gerard. This variable is denoted as MOUNT. We should expect a negative relation between this variable and the

[24]See Porter (1999) for a detailed analysis on this issue.

development of large cities. This would imply a negative relation between MOUNT and the development of the public health system, which in turn, will generate a positive one with σ^*. Finally, it is possible to create a third variable related to σ^* by combining the information in MOUNT and COAST. A simple way to do this is to consider the ratio of the two, COAST/MOUNT. Given the previous pattern of correlation, we should expect a negative relation between the latter variable and σ^*.[25]

The simple correlations between σ^* and the above mentioned variables are -0.19, 0.14 and -0.15 for the COAST, MOUNT and COAST/MOUNT variables, respectively. Notice that the sign of these correlations are in line with our initial guess.

To obtain potential instruments for $G_{t-j}\sigma^*$, we have multiplied the terrain variables by lagged inequality. Provided lagged inequality is predetermined, its interaction with the (exogeneous) terrain variables will also be so, implying that the exclusion restriction will hold.

The simple correlations between $G_{t-5}\sigma^*$, and G_{t-5}COAST, G_{t-5}COAST/MOUNT, and G_{t-5}MOUNT are -0.11, -0.11 and 0.12, respectively. Table **??** in Appendix B presents the first stage regressions associated to these instruments. When introduced one by one in the first stage regression, the three variables turn out to be significant (columns 1–3). However, if the three of them are introduced at the same time only G_{t-5}COAST is significant (column 4 in Table **??**). Accordingly, we have reestimated equation (**??**) using G_{t-5}COAST as instrument for $G_{t-5}\sigma^*$ and the output is presented in column 3 of Table **??**. Although the size of the coefficients differs considerably from those in column 2, the qualitative conclusions are very similar. Countries with values of σ^* smaller than 1.26 present a positive and significant relation between the top marginal tax rate and inequality and viceversa.[26] This value of σ^* (1.26) corresponds to the 72% percentile of the distribution. This implies

[25]Obviously, we could also consider the inverse of the previous variable (MOUNT/COUNT) as potential IV and the same is true for MOUNT and COAST. We have actually tried the 6 potential IVs and the ones that turned out to be more correlated with the endogenous variable according to the first stage regression are three mentioned in the text.

[26]Using a F test, the null hypothesis of $\beta_1 = \beta_2 = 0$ can be rejected at the 10% level (p-value 0.0519). On the other hand, tests of the hypothesis $\beta_2 = 0$ robust to weak instruments –such as the Anderson-Rubin test– still reject the null at conventional significance levels (p-value 0.024).

Variable	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
G_{t-5}	2.494	27.248***	78.877**						
	(8.384)	(10.060)	(33.221)						
$G_{t-5}\sigma^*$		-20.224***	-62.404**						
		(6.166)	(28.794)						
G_{t-4}				7.006	35.479***	72.175**			
				(8.813)	(10.214)	(34.831)			
$G_{t-4}\sigma^*$					-23.321***	-53.378*			
					(6.311)	(30.050)			
G_{t-6}							-2.299	18.810*	73.525**
							(8.157)	(10.201)	(32.771)
$G_{t-6}\sigma^*$								-16.975***	-60.976**
								(5.774)	(27.816)
GDPPC	3.184	3.521	4.224	2.830	3.100	3.448	3.280	3.610	4.463
	(3.537)	(3.418)	(3.316)	(3.555)	(3.442)	(3.379)	(3.581)	(3.473)	(3.305)
POP65	-0.147	-0.142	-0.132	-0.296	-0.334	-0.383	-0.040	-0.003	0.091
	(0.634)	(0.604)	(0.591)	(0.614)	(0.580)	(0.573)	(0.655)	(0.629)	(0.606)
POP	2.071	1.712	0.963	1.798	1.264	0.575	1.828	1.768	1.612
	(7.741)	(7.363)	(7.400)	(7.946)	(7.580)	(7.646)	(7.669)	(7.335)	(7.290)
DEMOC	-0.299	-0.283	-0.250	-0.245	-0.222	-0.191	-0.286	-0.279	-0.261
	(0.215)	(0.217)	(0.234)	(0.213)	(0.216)	(0.230)	(0.218)	(0.220)	(0.235)
R^2	0.587	0.596	0.557	0.583	0.594	0.576	0.589	0.596	0.549
Obs.	2097	2097	2097	2130	2130	2130	2058	2058	2058
C	126	126	126	127	127	127	127	127	127

TABLE 1. The relation between τ, σ^* and G.

Notes. Dependent variable is the top marginal tax rate, τ. All regressions contain country fixed effects and year dummies. Two stage least squares has been employed to obtain the estimates in columns 3, 6 and 9, while the remaining models have been estimated using standard fixed effects techniques. Robust standard errors adjusted for clustering at the country level are reported in brackets.* p<.10, ** p<.05, *** p<.01

that the list of countries with a positive or negative relation between the marginal tax rate and inequality is basically identical as that implied by column 2.

Columns 4–9 are similar to columns 1–3, but this time inequality lagged 4 (columns 4–6) and 6 years (columns 7–9) has been considered. The corresponding first-stage regressions can be found in columns 5–9 of Table **??** in Appendix B. The conclusions are identical to those described above: inequality is never significant when the restriction $\beta_2 = 0$ is imposed. However, a positive and significant coefficient is found for that variable when the interaction of G and σ^* is also introduced in the regression, whereas the interaction itself has a negative and significant coefficient.

We have also considered other lags of inequality. The results, not reported for the sake of brevity, show that the relation between inequality and the tax rate is weaker for small or for large values of j, resulting in estimates of $\beta_1$and β_2 that are not significantly different from zero in most cases. We believe that this pattern of significance is broadly consistent with our theory. Changes in inequality need some time to be realized and expressed so we should not be able to find responses in the short run. Similarly, changes in inequality that happened a long time ago might not be relevant any more since more recent events might be motivating different responses.

4.3. **The relation between the size of the state and inequality.** In this section we investigate the relationship between the size of the state, ϑ, and inequality. It follows from expression (**??**) that ϑ is a decreasing function of γ. In addition, since γ can be approximated by M/σ in most empirically relevant cases, as discussed in Section **??**, it follows that ϑ is also a decreasing function of M/σ. Although according to the model presented in the previous sections this relation is not linear, it seems reasonable to consider as a starting point whether a linear approximation can capture the implications of the theory.

We use a similar framework to the one considered in the previous section. In this case we estimate

$$\vartheta_{it} = \beta_1 G_{it-j} + \beta_2 \frac{G_{it-j}}{\sigma_i^*} + \beta_3 X_{it-1} + \mu_i + \eta_t + \epsilon_{it}. \tag{18}$$

In accordance with the theory, we should expect a value of β_1 not significantly different from zero together with a negative and significant value for β_2, which would imply that the marginal effect of inequality on the size of state is decreasing in σ in absolute value.

As in the previous section, we consider lagged values of inequality. One could expect that the size of state would respond even slower than the tax rate to changes in inequality, since implementing visible reductions or increases in this variable can take several years. For this reason, we analyze the impact on the current size of the state of changes in inequality occurring with a lag of 5, 6 and 7 years.

Variable	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
G_{t-5}	-0.030	0.034	0.160						
	(0.033)	(0.047)	(0.122)						
G_{t-6}				-0.041	0.024	0.183			
				(0.033)	(0.049)	(0.126)			
G_{t-7}							-0.052	0.011	0.167
							(0.032)	(0.050)	(0.127)
G_{t-5}/σ^*		-0.048**	-0.154						
		(0.022)	(0.098)						
G_{t-6}/σ^*					-0.048**	-0.175*			
					(0.023)	(0.095)			
G_{t-7}/σ^*								-0.045*	-0.169*
								(0.024)	(0.092)
GDPPC	-0.000	-0.002	-0.016*	0.000	-0.001	-0.016*	-0.000	-0.001	-0.014*
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)	(0.010)	(0.009)
POP65	0.003	0.003	0.001	0.003	0.003	-0.000	0.003*	0.003*	-0.000
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)
POP	-0.032	-0.039	-0.099**	-0.035	-0.042*	-0.104***	-0.041*	-0.048**	-0.106***
	(0.023)	(0.024)	(0.039)	(0.023)	(0.023)	(0.036)	(0.022)	(0.022)	(0.034)
DEMOC	0.000	0.000	0.000	0.000	0.000	0.000	-0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R^2	0.049	0.058	0.121	0.055	0.065	0.117	0.064	0.074	0.124
Obs.	2692	2692	1755	2640	2640	1728	2580	2580	1697
C	131	131	78	130	130	78	128	128	78

TABLE 2. THE RELATION BETWEEN THE SIZE OF THE STATE AND INEQUALITY.

Notes. Dependent variable is the size of the state, ϑ. All regressions contain country fixed effects and year dummies. Columns 3, 6 and 9 have been estimated using 2SLS while the remaining columns use standard fixed effects techniques. Robust standard errors adjusted for clustering are reported in brackets. * p<.10, ** p<.05, *** p<.01

Table **??** reports our estimates of equation (**??**). Columns 1, 4, and 7 present the results obtained after imposing the restriction β_2=0, for different lags of inequality (5 to 7 years). The sign of the coefficients of G_{t-j} is always negative, but estimates are never significant. If the restriction β_2=0 is dropped (see columns 2, 5, and 8), the coefficients of G_{t-j} are still not significant but those associated to G_{t-5}/σ^* are positive and significant, as the theory predicts.[27]

Since there are good reasons to suspect that σ^* can be endogenous, we have constructed instruments for G_{t-j}/σ^* in a similar fashion as before. This time, we have divided (lagged)

[27]In all cases, the joint hypothesis of $\beta_1 = \beta_2 = 0$ can be rejected at the 5% significance level.

inequality by the terrain variables introduced in the previous section. The first stage regressions (see Table **??** in Appendix B) show that only G_{t-j}COAST/MOUNT is significant this time. Columns 3, 6 and 9 in Table **??** present estimates of (**??**) with G_{t-j}/σ^* instrumented by G_{t-j}COAST/MOUNT. As before, the inequality variable on its own is not significant. However, (lagged) inequality divided by σ has a negative coefficient that is still significant at the 10% level, (with the exception of the coefficient of G_{t-5}/σ^* –column 3–, for which the p-value is 0.11).[28]

We have also considered larger values j (namely, j=$\{8, 9, 10\}$), and in these cases, the significance of the interacted term tends to vanish, suggesting that changes that happen too far back in time have no effect on the current size of the state.

Summarizing, the empirical results provide evidence supporting a negative relationship between the size of the state and inequality, and this relationship seems to be weaker the larger the value of where elasticity of substitution between privately and publicly provided services.

5. Concluding Remarks

In this paper we have provided an integrated analysis of income taxation and public expenditure. Individuals care about the reduction of their disposable income through taxation, but also about the benefits they will receive from the goods and services supplied by the government. How beneficial will public expenditure be to each particular tax payer depends on the specific egalitarian bias of the expenditure policy, as this fixes the return to the tax paid. We study the case where the political debate is on the distributional bias of the expenditure policy and, once the bias has been chosen by majority voting, taxes and size of government are adjusted to make them acceptable to the population. But at this point, whether individuals accept more or less income taxation critically depends on the substitutability between the publicly supplied and the market goods. The results are identical when we assume that the size of government is the salient political issue and taxes and bias in public expenditure are adapted accordingly.

[28]Similar results are obtained if techniques robust to weak instruments, as the Anderson-Rubin test, are employed to for the significance of β_2.

The first prediction of our voting model is straightforward. Higher inequality will make the median voter vote for more egalitarian expenditure policies. This result, however, has two more subtle implications, once we take into account the readjustment of the other fiscal policies. One is that the relationship between taxation and inequality is non-monotonic because its sign depends on the degree of substitutability between the publicly and the market supplied goods. The second one is that the relationship between inequality and the chosen size of government is again mediated by the degree of substitutability: substitutability reduces the marginal effect of inequality on the size of government. We empirically test the two implications. The first result is remarkable because the literature has so far been unable to identify a solid and significant relationship between inequality and taxation. The second issue has not yet been so extensively studied in the literature. The few existing empirical studies have tested a possible simple relationship between inequality and size of government. Our model tells us that this has to be conditioned by the substitutability. Indeed we find that while in isolation inequality does not have a significant role, we obtain a significant relationship once inequality is adequately interacted with substitutability.

These two results underscore the critical importance of the substitutability between the publicly and market supplied goods. In this paper we have taken just a first step and have considered such a fundamental policy as exogenously given. In our view, the literature has not given to this issue the relevance it deserves. In addition we don't have good empirical estimates of this substitutability. In the political as well as in the academic debate the issue of privatising public services has been seen as an issue about improving the efficiency in the management of a service. However, it is obvious that the more services are privatised the less indispensable is the state and hence the higher the resistance to taxation. Developing a full politico-economic model of privatizations is in our research agenda.

References

[1] Ahmed, S. and B.S. Yoo (1995), "Fiscal Trends and Real Economic Aggregates", *Journal of Money, Credit and Banking* 27, 985-1001.

[2] Alesina, A. and E. Glaeser (2004), *Fighting poverty in the US and Europe: A World of Difference*, Oxford University Press, Oxford.

[3] Alesina, A. and R. Wacziarg (1998), "Openness, Country Size and Government" *Journal of Public Economics* 69, 305-321.

[4] Amano, R.A. and T.S. Wirjanto (1998), "Government Expenditures and the Permanent- Income Model", *Review of Economic Dynamics* 1, 719-30.

[5] Ambler, S. and E. Cardia (1997) "Optimal Public Spending in a Business Cycle Model", in *Business Cycle and Macroeconomic Stability: Should We Rebuild Built-in Stabilizers?*, edited by J.-O. Hairault, P.-Y. Henin, and F. Portier. Kluwer Academic Press.

[6] Arrow, K. J. (1971), "A Utilitarian Approach to the Concept of Equality in Public Expenditures", *Quarterly Journal of Economics* 85, 409-15.

[7] Aschauer, D. (1985), "Fiscal Policy and Aggregate Demand", *American Economic Review* 75, 117-27.

[8] Auteri, M. and M. Costantini (2010), "A panel cointegration approach to estimating substitution elasticities in consumption", *Economic Modelling* 27(3), 782-787.

[9] Balestrino, A. (1999), "The desirability of in-kind transfers in the presence of distortionary taxes", *Journal of Economic Surveys* 13, 333-354.

[10] Bandyopadhyay, S. and J. Esteban (2009), "Redistributive taxation and Public Expenditures", Barcelona GSE, wp 416.

[11] Barro, R. (1981), "Output Effects of Government Purchases", *Journal of Political Economy* 89, 1086-21.

[12] Baxter, M. and R.G. King (1993), "Fiscal Policy in General Equilibrium", *American Economic Review* 83, 315-34.

[13] Bergstrom, T. and S. Blomquist (1996), "The Political Economy of Subsidized Day Care", *European Journal of Political Economy* 12, 443-458.

[14] Besley, T. and S. Coate (1991), "Public Provision of Private Goods and The Redistribution of Income", *American Economic Review* 81, 979-984.

[15] Blomquist, S. and V. Christiansen (1995), "Public Provision of Private Goods as a Redistributive Device in an Optimum Income Tax Model", *Scandinavian Journal of Economics* 97, 547-567.

[16] Blomquist, S. and V. Christiansen (1998), "Topping up or Opting Out? The Optimal Design of Public Provision Schemes", *International Economic Review* 39, 399-411.

[17] Blomquist, S., Christiansen, V. and L. Micheletto (2010), "Public provision of private goods and nondistortionary marginal tax rates", *American Economic Journal: Economic Policy* 2, 1-27.

[18] Boadway, R. and M. Marchand (1995), "The Use of Public Expenditures for Redistributive Purposes", *Oxford Economic Papers* 47, 45-59.

[19] Borck, R. (2007), "Voting, inequality, and redistribution", *Journal of Economic Surveys* 21, 90-109.

[20] Bouakez, H. and N. Rebei (2006), "Why Does Private Consumption Rise After a Government Spending Shock?" unpublished.

[21] Bruninger, T. (2005), "A partisan model of government expenditure", *Public Choice* 125, 409-429.

[22] Buchanan, J. and G. Tullock (1962), *The Calculus of Consent. Logical Foundations of Constitutional Democracy*, University of Michigan Press.

[23] Budge, I., Klingemann, D., Volkens, A., Bara, J. and M. McDonald (2001), *Mapping Policy Preferences. Estimates for Parties, Electorates, Governments 1945-1999*, Oxford OUP.

[24] Budge, I., Klingemann, D., Volkens, A., Bara, J. and M. McDonald (2006), *Mapping Policy Preferences (II). Estimates for Parties, Electorates, Governments 1995-2003*, Oxford OUP.

[25] Cardia, E., Kozhaya, N. and F. Ruge-Murcia (2003), "Distortionary Taxation and Labour Supply", *Journal of Money, Credit and Banking* 35, 763-85.

bib itemChetty, R., Looney, A. and K. Kroft (2009), "Salience and Taxation: Theory and Evidence", *American Economic Review*, 99: 1145-77.

[26] Christiano, L. and M. Eichenbaum (1992), "Cyclical Effects of Government's Employment and Good Purchases", *American Economic Review* 82, 430-50.

[27] Cremer, H. and F. Gahvari (1997), "In-Kind Transfers, Self-Selections and Optimal Tax Policy", *European Economic Review* 41, 97-114.

[28] Cusack, T. R. and P. Beramendi (2006), "Taxing Work", *European Journal of Political Research* 45, 43-73.

[29] Cusack, T.R. and V. Fuchs (2002),"Ideology, Institutions, and Public Spending", unpublished manuscript.

[30] Dalgaard, C-J., Hansen, H. and Th. Larsen (2005), "Income skewness, redistribution and growth: A reconciliation", European Policy Research Unit, University of Copenhagen, Department of Economics Working Paper.

[31] De Mello, L. and E. Thiongson (2003), "Income Equality and redistributive government spending", Washington, D.C.: IMF (Working Paper 03 / 14).

[32] Easterly, W. and S. Rebelo (1993), "Fiscal policy and economic growth: An empirical investigation", *Journal of Monetary Economics* 32, 417-458.

[33] Epple, D. and R.E. Romano (1996), "Public Provision of Private Goods", *Journal of Political Economy*, 104, 57-84.

[34] Ervik, R. (2000), "The hidden welfare state in comparative perspective: tax expenditures and social policy in eight countries", Unpublished doctoral dissertation, University of Bergen, Department of Comparative Politics.

[35] Evans, P. and G. Karras (1996), "Private and Government Consumption with Liquidity Constraints", *Journal of International Money and Finance* 15, 255-266.

[36] Ganghoff, S. (2005), "The Politics of (Income) Tax Structure", Yale Conference on the Distributive Politics, April 29 - 30, 2005.

[37] Gans, J.S. and M. Smart (1996), "Majority Voting with Single-Crossing Preferences", *Journal of Public Economics* 59, 219-237.

[38] Guesnerie, R. and K. Roberts (1984), "Effective Policy Tools and Quantity Controls", *Econometrica* 52, 59-86.

[39] Howard, C. (1997), "The hidden welfare state: Tax expenditures and social policy in the United States", Princeton University Press.

[40] Husted, T. and L. Kenny (1997), "The Effect of the Expension of the Voting Franchise on the Size of Government", *The Journal of Political Economy* 105(1), 54-82.

[41] Karras, G. (1994), "Government Spending and Private Consumption: Some International Evidence", *Journal of Money, Credit and Banking* 26-22.

[42] Longoni E. and F. Gregorini (2009), "Inequality, Political Systems and Public Spending", Working Papers 159, University of Milano-Bicocca, Department of Economics, revised Apr 2009.

[43] Meltzer, A. H. and S. F. Richard (1981), " A Rational Theory of the Size of Government", *Journal of Political Economy* 89, 914-927.

[44] Meltzer, A. H. and S. F. Richard (1985), "A Positive Theory of In-Kind Transfers and the Negative Income Tax", *Public Choice* 47, 231-65.

[45] Milanovic, B. (2000), "The Median-Voter Hypothesis, Income Inequality, and Income Redistribution: An Empirical Test with the Required Data", *European Journal of Political Economy* 16, 367-410.

[46] Moene, K.O. and M. Wallerstein (2001a), "Inequality, Social Insurance, and Redistribution", *American Political Science Review* 95, 859-874.

[47] Moene, K.O. and M. Wallerstein (2001b), "Targeting and political support for welfare spending", *Economics of Governance* 2, 3-24.

[48] Moene, K.O. and M. Wallerstein (2003), "Earnings Inequality and Welfare Spending. A Disaggregated Analysis", *World Politics* 55, 485-516.

[49] Mohl, P. and O. Pamp (2008), "Income inequality and redistributional spending: an empirical investigation of competing theories", *Public finance and management* 9.

[50] Pirttila, J. and M. Tuomala (2002), "Publicly Provided Private Goods and Redistribution: A General Equilibrium Analysis" *Scandinavian Journal of Economics* 104, 173-188.

[51] Porter, M. (1989), "Competitive Advantages of Nations",*Campus*, Rio Janeiro.

[52] Przeworski, A. (1999), "Minimalist conception of democracy: a defense", In: *Ian Shapiro/Casiano Hacker-Cordón eds., Democracy's Value*, Cambridge: Cambridge University Press, 23-55.

[53] Roberts, K. W. S. (1977), "Voting Over Income Tax Schedules", *Journal of Public Economics* 8, 329-340.

[54] Rodríguez, F. (1999), "Does distributional skewness lead to redistribution? Evidence from the United States", *Economics and Politics* 11(2), 171?199.

[55] Romer, T. (1975), "Individual Welfare, Majority Voting and the Properties of the Linear Income Tax", *Journal of Public Economics* 4, 163-185.

[56] Sabirianova, P., Buttrick, P. and D. Duncan (2010), "Global reform of per- sonal income taxation, 1981-2005: Evidence from 189 countries". *National Tax Journal* 63(3), 447-478.

[57] Tsebelis, G. (2002), *Veto Players*, Princeton University Press.

[58] Tsebelis, G. and E.C.C. Chang (2004), "Veto players and the structure of budgets in advanced industrialized countries", *European Journal of Political Research* 43, 449-476.

[59] Scervini, F. (2012), "Empirics of the median voter: democracy, redistribution and the role of the middle class", *Journal of Economic Inequality* 10, 529-550.

[60] Schwabish, J., Smeeding T. M. and L. Osberg (2006), "Income Distribution and Social Expenditures: A Cross-National Perspective", In D.B. Papadimitriou (ed.), *The Distributional Effects of Government Spending and Taxation*, Northampton, MA: Edward Elgar Publishing, pp. 247-288.

[61] Shelton, C. (2007) "The Size and Composition of Government Expenditure", *Journal of Public Economics* 91, 2230-2260.

[62] Solt, F. (2009), "Standardizing the World Income Inequality Database", *Social Science Quarterly* 90, 231-242.

[63] Swank, D. and S. Steinmo (2002), "The New Political Economy of Taxation in Advanced Capitalist Democracies", *American Journal of Political Science* 46, 642-655.

[64] Usher, D. (1977), "The welfare economics of the socialization of commodities", *Journal of Public Economics* 8(2), 151-168.

[65] Wagschal, U. (2001), "Two Neighbours - The Same Way? Political and institutional determinants of tax policy in Germany and Austria", ZP 2001/3 S.291-312.

[66] Wlezien, C. (2005), "On the salience of political issues: The problem with most important problems", *Electoral Studies* 24 (4), 555-579.

Appendix A

Proof of Proposition 1

Consider an arbitrary $\bar{g}$ and an expedicture policy γ. For a tax function be acceptable by an individual with income y it has to be that utility is maximal for $\beta = 1$ over all the affine transforms defined in (**??**). Differentiating the utility with respect to β in (**??**), equating it to zero, and evaluating at $\beta = 1$ we obtain

$$\frac{u_x\big(y - t(y), \gamma\bar{g} + (1-\gamma)t(y)\big)}{u_g\big(y - t(y), \gamma\bar{g} + (1-\gamma)t(y)\big)} = 1 - \gamma. \tag{19}$$

This expression implicitly defines $t(y)$ as a function of income y, an arbitrary expenditure $\bar{g}$, and expenditure bias γ, $\psi(y, \bar{g}, \gamma)$. Since the tax function has to be consensual, the first order condition (**??**) has to hold for all y. Integrating we find

$$\bar{t}(\bar{g}, \gamma) = \int \psi(y, \bar{g}, \gamma) dF(y).$$

It is immediate that when $\bar{g} = 0$ the tax satisfying (**??**) is such that $\psi(y, 0, \gamma) > 0$ for all y. Hence, $\int \psi(y, 0, \gamma) dF(y) > 0 = \bar{g}$. On the other hand, since from (**??**) we know that $\psi(y, \bar{g}, \gamma) < y$ for all y and $\bar{g}$, for $\bar{g} = \mu$ it has to be that $\int \psi(y, \mu, \gamma) dF(y) < \bar{g} = \mu$. Furthermore, it is easy to check that $\frac{\partial t(y)}{\partial \bar{g}} < 0$. Hence, there exists a unique budget balancing $\bar{g}^*$ such that

$$\bar{t}(\bar{g}^*, \gamma) = \int \psi(y, \bar{g}^*, \gamma) dF(y) = \bar{g}^*.$$

Hence, the unique consensual tax function is $t(y, \gamma) = \psi(y, \bar{g}^*, \gamma)$.

Proof of Proposition 2

In Proposition **??** we have obtained the condition for individual acceptability of a tax function, conditional on the net tax revenue and the expenditure policy. Since the fiscal policy has to be balanced, we have that $\bar{t} = \vartheta\mu$. Therefore, we can write $t(y) = \psi(y, \vartheta\mu, \gamma)$, where γ is arbitrary.

If $t(y)$ is universally acceptable this condition has to be satisfied by all incomes. Hence, we have that

$$\hat{t}(\vartheta\mu, \gamma) = \int \psi(y, \vartheta\mu, \gamma) dF(y). \tag{20}$$

We now show that there is a unique γ^* such that $\int \psi(y, \vartheta\mu, \gamma^*) dF(y) = \vartheta\mu$, so that $t^*(y) = \psi(y, \vartheta\mu, \gamma^*)$.

We start by observing that $\psi(y, \vartheta\mu, \gamma)$ is continuous in γ. From the first order condition (**??**) we can easily obtain that $\hat{t}(\vartheta\mu, \gamma) \to -\infty$ as $\gamma \to 1$. Furthermore, for $\gamma = 0$, for every y (**??**) becomes

$$\left[u_x\left(y - t(y), t(y)\right)\right] - \left[u_g\left(y - t(y), t(y)\right)\right] = 0,$$

so that $\hat{t}(\vartheta\mu, 0) = \hat{z}\mu$, where $\hat{z}$ is as defined in (**??**).

Therefore, a γ^* exists such that for every $\vartheta \in [0, \hat{z}]$ we have that $\hat{t} = \vartheta\mu$.

To prove uniqueness we shall show that $\hat{t}$ is strictly decreasing in γ.

Totally differentiating (**??**) with respect to $t(y)$ and to γ we obtain

$$\left\{-u_{xx} + 2(1-\gamma)u_{xg} - (1-\gamma)^2 u_{gg}\right\} dt(y) + \left\{u_g + [\bar{t} - t(y)][u_{xg} - (1-\gamma)u_{gg}]\right\} d\gamma = 0.$$

Noting now that

$$\frac{\partial u_g}{\partial t(y)} = -u_{xg} + (1-\gamma)u_{gg},$$

and that by, Assumption **??**,

$$t(y)[u_{xg} - (1-\gamma)u_{gg}] < u_g,$$

we obtain that $\frac{dt(y)}{d\gamma} < 0$. Hence,

$$\frac{d\hat{t}(\vartheta\mu, \gamma)}{d\gamma} < 0.$$

PROOF OF PROPOSITION 4

Using Proposition 1 in Gans and Smart (1996), a sufficient condition for the existence of a majority voting equilibrium is that the consensus tax function $t(y)$ be increasing in y for all possible γ.

By differentiating in (**??**) we can readily obtain that this condition is indeed met as

$$\frac{dt(y)}{dy} = \frac{-u_{xx} + (1-\gamma)u_{xg}}{-u_{xx} + 2u_{xg} - (1-\gamma)^2 u_{gg}} > 0. \tag{21}$$

This establishes existence.

We obtain the characterization of the chosen policy by differentiating the individual utility with respect to γ to get

$$\frac{du(x(y), g(y))}{d\gamma} = u_x \frac{dx(y)}{d\gamma} + u_g \frac{dg(y)}{d\gamma}.$$

Since the tax is *consensual* we can use (**??**) to obtain

$$\frac{du(x(y), g(y))}{d\gamma} = u_g \Big[\frac{dg(y)}{d\gamma} + (1-\gamma)\frac{dx(y)}{d\gamma} \Big].$$

We know that

$$\frac{dx(y)}{d\gamma} = -\frac{dt(y)}{d\gamma}$$

and that

$$\frac{dg(y)}{d\gamma} = \big(\bar{t} - t(y)\big) + \gamma \frac{d\bar{t}}{d\gamma} + (1-\gamma)\frac{dt(y)}{d\gamma}.$$

Hence,

$$\frac{du(x(y), g(y))}{d\gamma} = u_g \frac{d\bar{t}}{d\gamma} \left[\gamma - \frac{\bar{t} - t(y)}{-\frac{d\bar{t}}{d\gamma}} \right]. \tag{22}$$

Bearing in mind that $\frac{d\bar{t}}{d\gamma} < 0$, if we denote by $\hat{y}$ the solution to $t(\hat{y}) = \bar{t}$, we have that $\frac{du(x(y),g(y))}{d\gamma} < 0$ for all $y > \hat{y}$. Consequently, all individuals with $y \geq \hat{y}$ will prefer $\gamma(y) = 0$. Further, all individuals with $y < \hat{y}$ will prefer some $\gamma(y) < 1$. In particular, this will be true of the individual with the median income.

With respect to voting over the size of government, it is straightforward that quasitransitivity of the majority preference relationship also holds true when the preference relation is defined over ϑ. This is because in this case we continue to require that (**??**) be positive now for all possible $\bar{t}$, as it clearly is the case.

Appendix B

Variable	$[Obs]$	$[Mean]$	$[StdDev]$	$[Min]$	$[Max]$
τ	2130	39.734	14.526	0.000	90.000
ϑ	2692	0.154	0.058	0.014	0.504
σ^*	2692	1.092	0.982	0.125	6.591
G_t	2692	0.444	0.088	0.227	0.773
$G_t\sigma^*$	2082	0.497	0.440	0.036	3.047
G_t/σ^*	2692	0.741	0.571	0.052	2.948
GDPPC	2692	8.647	1.195	5.829	10.815
POP65	2692	7.765	4.893	1.854	21.406
POP	2692	16.420	1.473	13.383	21.004
DEMOC	2692	6.026	3.886	0.000	10.000
COAST	2097	10.028	20.484	0.000	142.045
MOUNT	2097	7.670	8.737	0.000	51.268
COAST/MOUNT	1723	2.238	9.043	0.000	83.874

Table B.1. Summary statistics.

Albania	1.338	Kyrgyzstan	1.178
Algeria	0.305	Lao PDRepublic	3.055
Argentina	0.921	Latvia	0.760
Armenia	2.412	Lebanon	1.883
Australia	0.498	Lesotho	0.907
Austria	0.320	Lithuania	0.386
Azerbaijan	3.901	Madagascar	0.570
Bangladesh	1.708	Malawi	1.104
Belarus	0.330	Malaysia	1.022
Belgium	0.349	Mali	1.327
Bhutan	0.397	Mauritania	0.482
Bolivia	0.556	Mauritius	0.902
Botswana	0.554	Mexico	1.229
Brazil	1.390	Mongolia	0.267
Bulgaria	0.605	Morocco	2.362
Burkina Faso	1.222	Mozambique	0.440
Burundi	1.649	Namibia	0.729
Cambodia	2.903	Nepal	2.550
Cameroon	3.793	Netherlands	0.471
Canada	0.424	New Zealand	0.290
Central African Republic	1.639	Nicaragua	0.853
Chad	1.410	Niger	0.910
Chile	0.892	Norway	0.200
China	1.389	Pakistan	3.097
Colombia	0.309	Panama	0.481
Costa Rica	0.350	Papua New Guinea	0.206
Croatia	0.177	Paraguay	1.565
Cyprus	1.393	Peru	0.749
Czech Republic	0.125	Philippines	1.542
Cote d'Ivoire	3.303	Poland	0.419
Denmark	0.203	Portugal	0.441
Djibouti	0.476	Republic of Korea	1.109
Dominican Republic	2.316	Republic of Moldova	0.835
Ecuador	1.437	Romania	0.420
Egypt	1.559	Russian Federation	0.588
El Salvador	1.139	Rwanda	1.180
Estonia	0.250	Senegal	1.447
Ethiopia	0.794	Serbia	0.388
Fiji	0.504	Sierra Leone	1.854
Finland	0.376	Singapore	1.782
France	0.260	Slovakia	0.256
Gabon	0.760	Slovenia	0.355
Gambia	1.567	South Africa	1.528
Georgia	5.984	Spain	0.396
Germany	0.267	Sri Lanka	1.181
Ghana	1.459	Swaziland	0.663
Greece	0.748	Sweden	0.197
Guatemala	1.772	Switzerland	0.760
Guinea	6.591	Tajikistan	2.961
Guinea-Bissau	2.896	Thailand	0.693
Guyana	0.184	Macedonia	0.399
Haiti	2.766	Trinidad and Tobago	1.071
Honduras	0.762	Tunisia	0.918
Hungary	0.358	Turkey	0.445
India	3.046	Turkmenistan	0.504
Indonesia	1.520	Uganda	2.580
Iran (Islamic Republic of)	1.245	Ukraine	0.780
Ireland	0.322	United Kingdom	0.231
Israel	0.617	United Republic of Tanzania	1.146
Italy	0.358	United States of America	1.250
Jamaica	0.904	Uruguay	0.856
Japan	0.225	Uzbekistan	1.022
Jordan	0.816	Venezuela	1.486
Kazakhstan	0.671	VietNam	2.117
Kenya	1.373	Yemen	1.319
		Zambia	0.706

Table B.2. Countries and values of σ^*

Variable	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
G_{t-5}	1.350***	0.930***	1.384***	1.177***				
	(0.162)	(0.183)	(0.161)	(0.332)				
G_{t-5}COAST	-0.006**			-0.009**				
	(0.003)			(0.004)				
G_{t-5}MOUNT		0.017*		0.012				
		(0.001)		(0.013)				
G_{t-5}COAST/MOUNT			-0.015***	0.006				
			(0.005)	(0.008)				
G_{t-4}					1.223***	1.336***		
					(0.324)	(0.158)		
G_{t-4}COAST					-0.008**	-0.005**		
					(0.004)	(0.003)		
G_{t-4}MOUNT					0.009			
					(0.012)			
G_{t-4}COAST/MOUNT					0.005			
					(0.008)			
G_{t-6}							1.170***	1.382***
							(0.350)	(0.174)
G_{t-6}COAST							-0.010**	-0.007**
							(0.004)	(0.003)
G_{t-6}MOUNT							0.013	
							(0.013)	
G_{t-6}COAST/MOUNT							0.008	
							(0.008)	
GDPPC	0.025	0.017	0.007	0.005	-0.001	0.019	0.009	0.028
	(0.022)	(0.022)	(0.025)	(0.024)	(0.027)	(0.025)	(0.021)	(0.019)
POP65	0.002	0.003	0.003	0.005	0.002	0.000	0.007	0.004
	(0.004)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)
POP	0.029	-0.012	-0.024	-0.002	-0.012	0.020	0.016	0.046
	(0.061)	(0.064)	(0.084)	(0.079)	(0.074)	(0.058)	(0.081)	(0.064)
DEMOC	0.001	0.000	0.002	0.002	0.002	0.001	0.001	0.000
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
R^2	0.613	0.634	0.619	0.644	0.644	0.615	0.644	0.609
Obs	2097	2097	1723	1723	1753	2130	1691	2058
C	126	126	104	104	105	127	105	127

TABLE B.3. THE RELATION BETWEEN τ, σ^* AND G: FIRST STAGE REGRESSIONS.

Notes. Dependent variables are $G_{t-5}\sigma^*$, $G_{t-4}\sigma^*$ and $G_{t-6}\sigma^*$ in columns 1–4, 5–6 and 7–8, respectively. All regressions contain country fixed effects and year dummies. Robust standard errors adjusted for clustering are reported in brackets. * p<.10, ** p<.05, *** p<.01

Variable	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
G_{t-5}	1.625***	1.238***	1.631***						
	(0.192)	(0.129)	(0.190)						
G_{t-5}MOUNT/COAST	-0.345								
	(0.238)								
G_{t-5}/MOUNT		0.044							
		(0.001)							
G_{t-5}MOUNT/COAST			-0.029**						
			(0.011)						
G_{t-6}				1.644***	1.247***	1.650***			
				(0.197)	(0.130)	(0.190)			
G_{t-6}/COAST				-0.352					
				(0.240)					
G_{t-6}/MOUNT					0.043				
					(0.061)				
G_{t-6}MOUNT/COAST						-0.030***			
						(0.011)			
G_{t-7}							1.687***	1.270***	1.686***
							(0.199)	(0.131)	(0.187)
G_{t-7}MOUNT/COAST							-0.367		
							(0.243)		
G_{t-7}/MOUNT								0.043	
								(0.061)	
G_{t-7}MOUNT/COAST									-0.031***
									(0.011)
GDPPC	-0.040*	-0.021	-0.021	-0.034	-0.021	-0.017	-0.029	-0.025	-0.016
	(0.023)	(0.019)	(0.021)	(0.023)	(0.018)	(0.020)	(0.023)	(0.016)	(0.019)
POP65	0.000	-0.007	-0.006	-0.003	-0.010	-0.009	-0.006	-0.014*	-0.012
	(0.008)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)	(0.007)	(0.008)	(0.007)
POP	-0.101	-0.170	-0.137	-0.105	-0.186**	-0.144*	-0.110	-0.205***	-0.156**
	(0.079)	(0.085)	(0.089)	(0.077)	(0.081)	(0.084)	(0.074)	(0.076)	(0.077)
DEMOC	0.001	0.000	0.000	0.001	0.001	0.001	0.002	0.001	0.001
	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
R^2	0.664	0.608	0.663	0.663	0.605	0.664	0.669	0.612	0.673
Obs	2127	2226	1755	2095	2181	1728	2057	2130	1697
C	95	109	78	95	108	78	95	106	78

TABLE B.4. THE RELATION BETWEEN τ, σ^* AND G: FIRST STAGE REGRESSIONS.

Notes. Dependent variables are G_{t-5}/σ^*, G_{t-6}/σ^* and G_{t-7}/σ^* in columns 1–3, 4–6 and 7–9, respectively. All regressions contain country fixed effects and year dummies. Robust standard errors adjusted for clustering are reported in brackets. * p<.10, ** p<.05, *** p<.01